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USEFULNESS OF FINANCIAL SOUNDNESS INDICATORS FOR RISK ASSESSMENT: THE CASE OF EU MEMBER COUNTRIES

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Abstract

The latest global financial crisis has highlighted the importance of monitoring the stability and soundness of the financial system. In 1999, the International Monetary Fund (IMF) undertook an initiative to develop and compile a set of macro-prudential indicators, the so called "Financial Soundness Indicators" (FSIs). This paper inspects the usefulness of these indicators to explain the financial soundness of EU member countries. Using ordered response models and credit ratings as a proxy for country risk, we examine the impact of capital adequacy, asset quality and earnings core FSIs on the financial risk of EU for the period 2008-2011. In addition, we explore the possible relationship between the financial development level of a country and its financial soundness. Our analysis provides evidence of the ability of some of these indicators to illustrate the health of the financial sector, as well as a significant positive relationship between financial development and financial soundness of a country.

USEFULNESS OF FINANCIAL SOUNDNESS INDICATORS FOR RISK ASSESSMENT: THE CASE OF EU MEMBER COUNTRIES

1. Introduction

Banking sector stability has received increased attention in the last decades (Čihák and Schaeck, 2010). The issue has acquired more relevance after the latest disruptions in the banking systems around the world, increasing the need to have appropriate instruments to assess and supervise risks.

Basically, two main approaches exist in research related to bank risk assessment: microprudential and macroprudential approach. The microprudential approach tries to identify weak banks by using mainly bank specific variables and dealing with individual financial institutions. In contrast, the macroprudential approach expects to monitor stability of the financial system as a whole, by examining aggregated micro-data and financial and macroeconomic information. Global financial difficulties have shown the limitation of traditional microprudential regulations to identify vulnerabilities of the financial system as a whole. Consequently, there has been a shift towards macroprudential approach in financial stability analysis (Cheang and Choy, 2011).

The International Monetary Fund (IMF), in accordance with its task of safeguarding worldwide financial stability, carried out an initiative to develop and compile a set of macroprudential indicators, ending with the publication of the "*Financial Soundness Indicators: Compilation Guide*" in 2006. Other international agencies have implemented similar initiatives, in particular, the Organization for Economic Co-operation and Development (OECD), Eurostat, Bank for International Settlements (BIS), European Central Bank (ECB), among others. Nevertheless, from the perspective of macroprudential

indicators, the IMF work is probably the most interesting because it aims to develop international standards for the compilation of financial soundness indicators (Mörttinen *et al.*, 2005).

Financial Soundness Indicators (FSIs) are divided into two groups (see Appendix 1). The first one consists of core indicators relating to five relevant basic areas of the banking business, compatible with the so-called CAMELS methodology.[1] The remaining indicators belong to the encouraged set, including some other banking sector measures, and also indicators from non-bank financial institutions, non-financial corporations, households, financial markets and property markets. On July 2009, a first group of countries initiated regular reporting and dissemination of FSIs data and metadata though the IMF´s website. Regarding EU member countries, the status of FSIs reporting to the IMF has significantly improved in the last years.

Literature on IMF´s FSIs has focused on theoretical aspects as the main concepts, compilation methodologies and uses, sometimes in comparison with other indicators (Sundararajan *et al.*, 2002; Slack, 2003; Mörttinen *et al.*, 2005; Agresti *et al.*, 2008; San Jose *et al.*, 2008; among others). However, very few studies have developed an econometric model including these indicators. Notable exceptions are the works by Babihuga (2007), Akhter and Daly (2009) and Čihák and Schaeck (2010), which have studied empirically the macroeconomic determinants of certain FSIs and their usefulness. We pursue two main objectives. On the one hand, we aim to empirically examine the impact of a selection of FSIs on EU countries´ risk. On the other hand, we try to contrast the hypothesis that financial soundness varies across EU countries, depending on their financial development level.

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[1]Methodology for the assessment of the soundness of individual financial institutions, using indicators of Capital adequacy, Asset quality, Management soundness, Earnings, Liquidity and Sensitivity to market risk.

This paper contributes to the literature in three ways. First, this study is the first to investigate the ability of selected FSIs to explain the financial soundness (or lack of risk) of a country, in particular, we examine the possible impact of each individual core FSIs. Although there are other macroprudential indicators, we have focused on FSIs published in the IMF website because the literature has so far made little use of these indicators in the European context. Second, unlike existing literature (e.g., Akhter and Daly, 2009; Daly and Akhter, 2009; Čihák and Schaeck, 2010) we focus on EU member countries throughout the crisis period. We believe that such studies are important and necessary especially at the moment when the European community is concerned about the soundness of the banking sector and systemic risk. Finally, different from some research which use the probability of observing a banking crisis in an economy and year (e.g., Caprio and Klingebiel, 1996; Kaminsky and Reinhart, 1999; Demirgüç-Kunt and Detragiache, 2005; Čihák and Schaeck, 2010), we use sovereign ratings of the three main rating agencies as a proxy for the financial soundness of a country and develop ordered response models.

After this introduction, we proceed as follows. The next section presents a review of related literature. Section 3 provides some relevant aspects on data and methodology. Section 4 presents the main analysis and results. Finally, section 5 summarizes and concludes.

2. Literature review

There is a lot of macroprudential research focused on developing Early Warning Systems (EWS) to anticipate and predict financial crisis (e.g., Demirguc-Kunt and Detragiache, 1998; Kaminskyand Reinhart, 1999; or more recently, Davis and Karim, 2008; Barrell *et al.*, 2010; Poghosyan and Cihák, 2011; Bucevska, 2011; Duttagupta and Cashin, 2011;

among others). However, the existing literature on FSIs is not as wide, highlighting a need for further research.

Three kinds of empirical studies on FSIs can be distinguished according to their purpose. A first group of research studies the evolution of certain FSIs to conclude about the soundness of different banking systems. Daly and Akhter (2009) consider three aspects of financial soundness (capital adequacy, asset quality and profitability), observing their evolution in a sample of countries all over the world from 1998 to 2006, through a set of indicators. They conclude that the analyzed set of FSIs allows some comparative analysis of financial health across countries, despite some methodological and compilation differences. More recently, Maudos (2012) studies the evolution of some FSIs in the Spanish banking sector, in comparison with those from the Euro area. Results reveal the weaker position of the Spanish banking sector, both in absolute terms and in comparison with the euro area, capturing as well the improved of solvency ratios.

The second group of empirical studies analyzes the macroeconomic determinants of certain FSIs. Babihuga (2007), using data of capital adequacy, asset quality and profitability indicators for 96 countries from 1998 to 2005, finds that FSIs fluctuate strongly with the business cycle, inflation, real exchange rate and short-term interest. Akhter and Daly (2009), considering capital adequacy and profitability as key aspects of financial soundness, use panel data for more than 50 countries and individually model each of these indicators with different sets of explanatory variables.[2] The analysis reveals the strong influence of business cycle, inflation, real effective exchange rate and size of industry on capital adequacy. Furthermore, the results provide evidence that bank´s

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[2] The ratios of regulatory capital to risk-weight assets and capital to assets have been used as the indicator of capital adequacy, while the return on asset has been used as the indicator of profitability.

profitability is determined by a combination of macroeconomic, bank specific and industry characteristics such as inflation and credit risk.

The third kind of empirical studies examines the usefulness of FSIs. The main work in this group so far is Čihák and Schaeck (2010). These authors, drawing upon a set of FSIs for 100 developed and developing economies, present an econometric analysis of the applicability of these ratios for the identification of banking crisis. A multivariate logit model is estimated for the period 1994-2007, whose results suggest that some of the indicators can be useful for identifying weak banking systems. In particular, bank return on equity and nonbank corporate leverage are good indicators for the build-up of systemic problems. They also find some evidence that the contemporaneous ratios of nonperforming loans to total loans and capital adequacy are useful for the identification of banking turmoil.

Our paper, similar to Čihák and Schaeck (2010), examines the usefulness of some FSIs proposed by IMF. However, it differs in the purpose, methodology, variables, period and countries analyzed. We inspect the ability of some FSIs to explain the general financial soundness of the countries, while Čihák and Schaeck (2010) focus on the particular event of a banking crisis. Different from them, we use sovereign ratings of the three main rating agencies as a proxy for the financial soundness of EU countries and develop ordered response models.[3]

Furthermore, we aim to investigate whether a positive relationship between financial development level and financial soundness of a country can be observed. Although a large body of economic literature supports the premise that, in addition to many other important factors, the long-term economic growth of a country is related to its

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[3]Appendix 2 collects some relevant studies which have used sovereign ratings as a dependent variable as well, developing different econometric models.

degree of financial development (Goldsmith, 1969; Levine and Zervos, 1998; or Levine, 2004; among others), there is not so much research to support that hypothesis.

Financial development is measured by factors such as size, depth, access, efficiency and stability of a financial system, which includes its markets, intermediaries, assets, institutions, and regulations. The higher the degree of financial development, the wider the availability of financial services that allows the diversification of risk (WEF, 2012), that is why we initially expected to find that a high level of financial development has a positive influence on the financial soundness of a country.

3. Data and methodological aspects

3.1. *Sample*

Our sample comprises the EU-27 member countries. Given data availability for the explanatory variables, our estimations cover only the period 2008-2011. We agree to consider data at the end of each year. We obtained the rating information from Bankscope-Bureau Van Dijk database whereas the FSIs were acquired from IMF database. Overall, we have an unbalanced panel with 27 countries and a maximum of 4 yearly observations per country. Tables 1 and 2 show the number of observations that constitute the sample, organized by year and country.

Table 1. Number of observations by year

Year	Observations	Percentage
2008	25	24.51
2009	25	24.51
2010	26	25.49
2011	26	25.49
Total	*102*	*100*

Table 2. Number of observations by country

Country	Observations	Percentage
Austria	4	3.92
Belgium	4	3.92
Bulgaria	4	3.92
Cyprus	4	3.92
Czech Republic	4	3.92
Denmark	2	1.96
Estonia	4	3.92
Finland	4	3.92
France	4	3.92
Germany	4	3.92
Greece	4	3.92
Hungary	4	3.92
Ireland	4	3.92
Italy	4	3.92
Latvia	4	3.92
Lithuania	4	3.92
Luxembourg	3	2.94
Malta	4	3.92
Netherlands	4	3.92
Poland	4	3.92
Portugal	4	3.92
Romania	4	3.92
Slovak Republic	1	0.98
Slovenia	4	3.92
Spain	4	3.92
Sweden	4	3.92
United Kingdom	4	3.92
Total	*102*	*100*

3.2. *Dependent variable: sovereign rating*

Previous literature on credit risk of companies and countries has used credit ratings as proxy for credit risk (Butler and Fauver, 2007; Demirovic and Thomas, 2007; Afonso *et al.*, 2011). Sovereign ratings inform of the ability and willingness of a country to repay its public debt on time (Afonso *et al.*, 2011), they *"represent a measure of the credit risk of a given country"* (Alsakka and apGwilym, 2010, p.141). We use long-term sovereign credit

ratings as a proxy for the financial soundness of countries: the better the rating, the lower the country risk, and the higher the financial soundness of this country.

We built a database with sovereign ratings attributed by the three main rating agencies, S&P, Moody´s and Fitch Ratings during the period 2008-2011. The rating of a particular year is the one attributed at 31[st]December. Some countries do not have a rating attributed by all three agencies (Table 3). For this reason, models which use S&P ratings as dependent variable have fewer observations than the ones which use Moody´s or Fitch ratings.

Table 3. Number of observations by rating agency

Year	Moody´s	S&P	Fitch
2008	25	14	25
2009	25	16	25
2010	26	19	26
2011	26	26	26
Total	*102*	*75*	*102*

Ratings are converted into a numerical equivalent and then they are grouped in 5 categories.[4] In our scale, 1 denotes the highest rating (AAA for S&P and Fitch, Aaa for Moody´s) while 5 denotes the lowest (below BB+ for S&P and Fitch, below Ba1 for Moody´s). The number of observations falling into each of the rating groupings is set out in Table 4. When a country is rated by more than one of the agencies in a single year, each rating is considered as a separate observation.

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[4]The number of categories is based on the sample size and economic considerations.

Table 4. Ratings conversion to numerical scale

MOODY´S	S&P	FITCH	Assigned value	No. of observations	Percentage
Aaa	AAA	AAA	1	112	40.143%
Aa1	AA+	AA+	2		
Aa2	AA	AA	2	49	
Aa3	AA-	AA-	2		17.563%
A1	A+	A+	3		
A2	A	A	3	49	
A3	A-	A-	3		17.563%
Baa1	BBB+	BBB+	4		
Baa2	BBB	BBB	4	57	
Baa3	BBB-	BBB-	4		20.430%
Ba1	BB+	BB+	5		
Ba2	BB	BB	5		
Ba3	BB-	BB-	5	12	
Ca	CC	CCC	5		4.301%
				279	100%

Note: The table shows the conversion of qualitative ratings to numerical values. The sample comprises 279 rating observations for the 27 countries during 2008-2011. Table 3 shows the number of observations by rating agencies and year.

3.3. *Explanatory variables: selected FSIs*

The study considers seven FSIs belonging to the core set. The *Survey on the Use, Compilation, and Dissemination of Macroprudential Indicators*, conducted by the IMF in 2000, revealed that all major categories of FSIs were broadly useful. In particular, capital adequacy, asset quality and profitability indicators were most widely deemed to be useful, followed by indicators of liquidity and sensibility to market risk (Sundararajan *et al.*, 2002).

We consider three main aspects of CAMELS methodology: capital adequacy, asset quality, and earnings/profitability. Each aspect is represented by at least one indicator (see Table 5). We select the indicators on the basis that they are used in prior studies and they are available for the countries in the sample.

3.4. *Additional explanatory variables*

In addition, we include a proxy for the financial development level of the countries to explore the relationship between financial development and financial soundness. Some variables commonly used to measure financial development level are *"Credit/GDP"*, *"Market capitalization of listed companies/GDP"* and the sum of both, *"Total Capitalization/GDP"* (Maudos and Fernández, 2006). Levine and Zervos (1993), Rajan and Zingales (1998), Maudos and Fernández de Guevara (2006), Bena and Ondko (2012), among others, use some of these variables as proxies for financial development.

We consider the *"Total Capitalization/GDP"* (FDL) which is obtained as the sum of two variables: *"Credit/GDP"* and *"Capitalization of listed companies/GDP"*. *"Credit/GDP"* is calculated by dividing the domestic credit provided by the banking sector by the Gross Domestic Product. The *"Capitalization of listed companies"* is calculated by using the share price times the number of shares outstanding of the domestically incorporated companies listed on the country´s stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles. Data were obtained from the World Bank database *"World Development Indicators"*.

Finally, a set of year dummy variables is included to account for macroeconomic conditions and time-specific effects. We decided to include these variables with the only aim to control the effect of all macroeconomic variables, but we are not interested in the macroeconomic determinants of financial soundness.[5]

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[5]Akhter and Daly (2009) provide an analysis of macroeconomic determinants of some financial soundness indicators.

Table 5. Description of the explanatory variables

Category	Indicator	Notation	Description	Expected sign
FINANCIAL SOUNDNESS INDICATORS				
CAPITAL ADEQUACY	Regulatory Capital to risk-weight assets	**RCRWA**	This FSI is calculated using total regulatory capital as the numerator and risk-weighted assets as the denominator. Data are compiled in accordance with the guidelines of either Basel I or Basel II.	- / +
	Nonperforming loans net of provisions to capital	**NPLNPC**	This FSI is calculated by taking the value of nonperforming loans (NPLs) less the value of specific loan provisions as the numerator and capital as the denominator. Capital is measured as total capital and reserves in the sectorial balance sheet; for cross-border consolidated data, total regulatory capital can also be used.	-
ASSET QUALITY	Nonperforming loans to total gross loans	**NPLTGL**	This FSI is calculated by using the value of NPLs as the numerator and the total value of the loan portfolio (including NPLs, and before the deduction of specific loan loss provisions) as the denominator	+
EARNINGS AND PROFITABILITY	Return on assets	**ROA**	This FSI is calculated by dividing net income before extraordinary items and taxes (as recommended in the FSI Guide) by the average value of total assets (financial and nonfinancial) over the same period.	-
	Return on equity	**ROE**	This FSI is calculated by dividing net income before extraordinary items and taxes by the average value of capital over the same period. Capital is measured as total capital and reserves as reported in the sectorial balance sheet; for cross-border consolidated data, Tier 1 capital can also be used	-
	Interest margin to gross income	**IMGI**	This FSI is calculated by using net interest income as the numerator and gross income as the denominator. It is a profitability ratio, which measures the relative share of net interest earnings— interest earned less interest expenses— within gross income.	-
	Noninterest expenses to	**NIEGI**	This FSI is a profitability ratio, which measures the size of	-

	gross income		administrative expenses within gross income. It measures the efficiency of deposit takers' use of resources.	
ADDITIONAL EXPLANATORY VARIABLES				
FINANCIAL DEVELOPMENT LEVEL	Total capitalization/ GDP	**FDL**	This indicator is obtained as the sum of two variables: "Credit/GDP" and "Capitalization of listed companies/GDP".	-
CONTROL VARIABLES	**Year Dummies**		These are control variables	

Notes: Descriptions for FSIs come from IMF definitions.

3.5. *Methodology*

There are two main econometric approaches in the credit ratings literature: linear regression methods (Cantor and Packer, 1996; Afonso, 2003; Mora, 2006; Butler and Fauver, 2007; Ratha et al. 2011; Afonso et al., 2011) and ordered response models (Trevino and Thomas, 2001; Hu et al., 2002; Bissoondoyal-Bheenick, 2005; Demirovic and Thomas, 2007; Alsakka and apGwilym, 2010; Afonso et al., 2011).

Linear regression methods on a numerical representation of the ratings allow for a straightforward generalization to panel data by doing fixed and random effects estimation (Mora, 2006) but it faces some criticisms. As rating is a qualitative ordinal measure, a linear representation of the ratings is not adequate because it implicitly assumes that the difference between any two adjacent categories is always equal, and the coefficient estimates are biased (Afonso et al., 2011). Ordered response models can solve these problems because they take into consideration the nature of the dependent variable (the rating is a discrete variable and reflects an order in terms of probability of default). This is a widely accepted approach in literature related to credit ratings (Williams et al., 2013).

For this reason, we estimate our specification using ordered response methods[6], although we report results from linear models as well in order to establish some comparison of both methodologies.

Ordered response models stem from a latent or unobserved variable model which satisfies the assumptions of the classic linear model.[7] R_{it}^* describes the credit risk of a country i at year t, which depends on several factors, how these factors enter the R_{it}^* function is uncertain, but it is conventional to use a linear function (Greene, 2012, p.825). If we suppose that the unobserved latent variable R_{it}^* is a linear function of k factors whose values for country i at year t are $X_{k,it}$, k=1,…, K, then the country risk can be represented as:

$$R_{it}^* = \sum_{k=1}^{K} \beta_k X_{k,it} + \varepsilon_{it} = Z_{it} + \varepsilon_{it} \qquad (1)$$

As ratings are arranged in descending order (AAA=1, AA+=2 and so on), an increase in the value of the kth factor for a particular country will cause a rise in its risk (i.e. a deterioration of its financial soundness) if β_k >0, and a drop in the risk (an improvement of its financial soundness) if β_k <0.

Country risk is classified with threshold values C_{j-1} (where j is a number of possible outcomes, in our case j=5) so that $C_1 < C_2 ... < C_{j-1}$ and the final rating (the observed variable R_{it}) is given by:

$$
\begin{aligned}
R_{it} &= 1 \text{ if } R_{it}^* \le C_1 \\
R_{it} &= 2 \text{ if } C_1 < R_{it}^* \le C_2 \\
R_{it} &= 3 \text{ if } C_2 < R_{it}^* \le C_3 \qquad (2) \\
&\dots \\
R_{it} &= j \text{ if } C_{j-1} \le R_{it}^*
\end{aligned}
$$

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[6] The reduced number of observations in the database makes the use of panel data methodology inadvisable. For this reason, we estimate pooled ordered probit and logit models. Standard errors are clustered by countries to take into account the country effect in the ratings.
[7] See Wooldridge (2002)

We consider two different distributions: ordered logit and ordered probit.[8] The first one assumes that ε is logistically distributed across observations, whereas the second one considers the normal distribution for ε. The cumulative distribution functions of the random variable X are:

For an order logit model:

$$F(X) = Pr\ (X \leq x) = \wedge(x) = \frac{1}{1+e^{-x}} \tag{3}$$

For an order probit model:

$$F(X) = Pr\ (X \leq x) = \Phi(x) = \int_{-\infty}^{X_0} \frac{1}{\sqrt{2\sigma^2\pi}} e^{-(X-\mu)^2/2\sigma^2} \tag{4}$$

The probabilities of a country taking any of rating categories are defined by:

$\boldsymbol{Pr}\ (\boldsymbol{R_{it}} = \boldsymbol{1}) = P(R_{it}^* \leq C_1) = P(Z_{it} + \varepsilon_{it} \leq C_1) = P(\varepsilon_{it} \leq C_1 - Z_{it}) = F(C_1 - Z_{it})$

$\boldsymbol{Pr}\ (\boldsymbol{R_{it}} = \boldsymbol{2}) = P(C_1 < R_{it}^* \leq C_2) = P(R_{it}^* \leq C_2) - P(R_{it}^* \leq C_1) = P(Z_{it} + \varepsilon_{it} \leq C_2) - P(Z_{it} + \varepsilon_{it} \leq C_1) = P(\varepsilon_{it} \leq C_2 - Z_{it}) - P(\varepsilon_{it} \leq C_1 - Z_{it}) = F(C_2 - Z_{it}) - F(C_1 - Z_{it})$

$\dots$
$\dots$

$\boldsymbol{Pr}\ (\boldsymbol{R_{it}} = \boldsymbol{j}) = P(R_{it}^* \geq C_{j-1}) = P(Z_{it} + \varepsilon_{it} \geq C_{j-1}) = P(\varepsilon_{it} \geq C_{j-1} - Z_{it}) = 1 - F(C_{j-1} - Z_{it})$

$\tag{5}$

The parameters of equations and the cut-off points are estimated using maximum likelihood.[9]

4. Results

4.1. *Baseline model*

Firstly, we report results for each rating agency separately. We estimate both logit and probit ordered models (Table 6).

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[8]These models are explained in detail in Greene (2012, Chapter 18).
[9]Results are obtained using STATA/Special Edition, 10.0.

Results show significant coefficients for NPLTGL, NPLNPC, NIEGI and FDL, which indicate a relevant impact of these variables on the rating and therefore on the financial soundness of countries. NPLTGL has a significantly negative impact on financial soundness, so that an increase of the percentage of non-performing loans reduces the asset quality of the banking sector and causes a deterioration of the country´s financial health. The other two FSIs (NPLNPC and NIEGI) have significantly positive effects on financial soundness. Due to the nature of the allocations to provisions, an increase in NPLNPC ratio means a reduction in non-performing loans in comparison with the previous year, i.e. a decrease of the risk and therefore an improvement in the financial soundness. The sign of NIEGI ratio can be explained by the efficiency of deposit takers in the use of resources, the higher the NIEGI, the higher the efficiency and therefore the higher the financial soundness of the banking system.

Finally, the negative sign of FDL confirms the hypothesis that a positive relationship between financial development level and financial soundness of a country can be observed, probably due to the wider availability of financial services that allows the diversification of risk in countries with a higher level of financial development.

Pseudo R^2 is used to compare the overall ability to provide information of the nested models, in general, higher values indicate better model fit.[10] However, in order to compare different kinds of models such as logit and probit, we estimate the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC). Regarding these measures, logit models fit better than probit. Both ordered models (probit and logit) produce similar findings for significant variables.

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[10] See Gujarati and Porter (2010).

Table 6. Ordered Probit and Logit Models for each rating agency

	MOODY´S		S&P		FITCH	
	LOGIT	PROBIT	LOGIT	PROBIT	LOGIT	PROBIT
NPLTGL	0.7926***	0.3616***	0.8307**	0.4124***	1.0189**	0.3788***
	(0.2483)	(0.0836)	(0.3918)	(0.1366)	(0.4291)	(0.1213)
RCRWA	0.1487	0.0165	-0.1926	-0.0886	0.1566	-0.0080
	(0.1627)	(0.0927)	(0.2581)	(0.1001)	(0.1915)	(0.1009)
NPLNPC	-0.0686***	-0.0323***	-0.0980	-0.0426*	-0.0875**	-0.0333***
	(0.0246)	(0.0098)	(0.0722)	(0.0241)	(0.0431)	(0.0125)
ROA	0.3312	0.2648	0.7225	0.3476	0.7823	0.4861
	(0.7045)	(0.3905)	(1.2986)	(0.5982)	(0.6746)	(0.3802)
ROE	-0.1460	-0.0183	-0.0502	-0.0229	-0.0416	-0.0329
	(0.0588)	(0.0307)	(0.0983)	(0.0445)	(0.0568)	(0.0300)
IMGI	0.0349*	0.0194*	0.0114	0.0007	0.0246	0.0117
	(0.0195)	(0.0102)	(0.0330)	(0.0144)	(0.0189)	(0.0095)
NIEGI	-0.0537**	-0.0274**	-0.0286	-0.0101	-0.0425**	-0.0189*
	(0.0219)	(0.0113)	(0.0338)	(0.0145)	(0.0220)	(0.0106)
FDL	-0.0108***	-0.0064***	-0.0146**	-0.0093***	-0.0098**	-0.0061***
	(0.0033)	(0.0018)	(0.0064)	(0.0034)	(0.0039)	(0.0020)
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	102	102	75	75	102	102
Log likelihood	-88.0666	-92.8630	-51.9863	-53.1256	-83.1274	-91.3542
Wald $\text{chi}^2(df)$	57.63(11)	76.68(11)	75.76(11)	113.57(11)	36.27(11)	76.85(11)
Prob<chic^2	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000
Pseudo R^2	0.4121	0.3801	0.4644	0.4527	0.4259	0.3691
AIC	206.133	215.726	133.973	136.251	196.255	212.708
BIC	245.508	255.101	168.735	171.013	235.629	252.083
C1	0.0823	-1.2015	-4.9103	-2.5494	1.6457	-1.0996
C2	1.6688	-0.3400	-3.2600	-1.6613	3.8194	-0.0032
C3	4.5728	1.1874	-2.0882	-1.0265	5.6383	0.9197
C4	9.7689	3.1524	2.7672	1.3251	15.4419	3.9521

Notes: This table reports the coefficients and the cut-off points (C1, C2, C3, C4) of ordered logistic and probit regressions of the sovereign ratings attributed by each rating agency. Standard errors (reported in parentheses) are clustered by countries (they are adjusted for 27 clusters). See Tables 3 and 4 for the number of observations by rating agencies and the numerical values assigned to the credit ratings. Pseudo R^2 is a goodness-of-fit measure, in general, higher values indicate better model fit. AIC is a measure of the relative quality of the statistical models, which evaluates the trade-off between the goodness of fit of the models and their complexity. BIC is closely related to the AIC, it is based, in part, on the likelihood function. The number of observations used in calculating BIC is N. Models with lower values of AIC and BIC are preferred. *, **, ***─ statistically significant at 10, 5, 1%.

4.2. *Robustness checks*

As a robustness check, we re-estimate the models considering only one dependent variable which jointly contemplates the ratings of the three main agencies.[11] In order to do this, we introduce agency dummy variables. Thus, when a country is rated by more than one of the agencies in any one period, each rating is considered to be a separate observation.

Results for significant variables (Table 7) are quite similar to the ones showed in Table 6. The only three variables which are robust to alternative specification of the dependent variable and different models are NPLTGL, NPLNPC and FDL.

Table 7. Ordered Probit and Logit Models using agency dummies

	LOGIT	PROBIT
NPLTGL	0.8455***	0.3790***
	(0.2447)	*(0.0834)*
RCRWA	0.0832	-0.0119
	(0.1464)	*(0.0878)*
NPLNPC	-0.0798***	-0.0347***
	(0.0300)	*(0.0116)*
ROA	0.4750	0.3418
	(0.6315)	*(0.3826)*
ROE	-0.0266	-0.0224
	(0.0504)	*(0.0295)*
IMGI	0.0238	0.0116
	(0.0184)	*(0.0100)*
NIEGI	-0.0416**	-0.0195*
	(0.0208)	*(0.0109)*
FDL	-0.0107***	-0.0065***
	(0.0030)	*(0.0017)*
Year dummies	Yes	Yes
Agency dummies	Yes	Yes
N	279	279
Log likelihood	-235.2819	-246.9875
Wald chi^2*(df)*	*88.2(13)*	*114.42(13)*
Prob<chic^2	0.0000	0.0000

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[11]Demirovic and Thomas (2007) and Trujillo-Ponce *et al.*, forthcoming, among others, have used this methodology.

Pseudo R^2	0.4132	0.3840
AIC	504.564	527.975
BIC	566.294	589.706
C1	0.2169	-0.9784
C2	1.9179	-0.0513
C3	3.9373	1.0161
C4	10.0852	3.3574

Notes: This table reports ordered logistic and probit regressions of the sovereign ratings provided by the international rating agencies. The dependent variable jointly considers the ratings of the three major agencies. See Table 4 for the numerical values assigned to the credit ratings. C1, C2, C3, C4 are the cut-off points. Standard errors (reported in parentheses) are clustered by countries (they are adjusted for 27 clusters). See Table 6 for the meaning of Pseudo R^2, AIC and BIC. The number of observations used in calculating BIC is N. *, **, ***— statistically significant at 10, 5, 1%.

Finally, although we have explained that linear representation of the ratings is not adequate, we report results from pooled linear regression models for each rating agency (Table 8) in order to compare the findings highlighted above.[12] We transform qualitative ratings into numerical data for linear regression analysis as follows: 1 denotes the highest rating (AAA for S&P and Fitch, Aaa for Moody´s) while 14 denotes de lowest (below Ca for Moody´s, below CC for S&P, below CCC for Fitch). Table 4 shows the 14 rating categories. Once again, models show significant effects only for NPLTGL, NPLNPC and FDL. In addition, RCRWA appear to be relevant to explain the country risk. Previous literature has found evidence of this positive relationship between capital adequacy and bank risk, explaining that banks try to increase their level of capital by acquiring more risk in their portfolios.[13]

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[12]We estimate pooled models due to the reduced number of observations in the database which make the use of panel data methodology inadvisable. Firstly, we estimated all the models including the constant, but it was not statistically significant, so we re-estimated the models again without the constant.
[13]See Porter and Chiou (2013).

Table 8. Pooled Linear Models for each rating agency

	MOODY´S	S&P	FITCH
NPLTGL	0.6575***	0.6799***	0.5847***
	(0.1076)	(0.1439)	(0.1111)
RCRWA	0.2252***	0.1809	0.2106***
	(0.0626)	(0.1124)	(0.0670)
NPLNPC	-0.0286***	-0.0309***	-0.0260***
	(0.0067)	(0.0073)	(0.0064)
ROA	0.1724	0.5984	0.1719
	(0.7830)	(1.0096)	(0.7420)
ROE	0.0311	0.0088	0.0182
	(0.0494)	(0.0599)	(0.0443)
IMGI	0.0127	-0.0116	0.0121
	(0.0180)	(0.0262)	(0.0186)
NIEGI	-0.0311	-0.0088	-0.0282
	(0.0183)	(0.0251)	(0.0192)
FDL	-0.0063*	-0.0070*	-0.0071**
	(0.0031)	(0.0053)	(0.0032)
Year dummies	YES	YES	YES
N	102	75	102
F	317.76	53.90	301.67
Prob<F	0.0000	0.0000	0.0000
R^2	0.8754	0.8576	0.8674

Notes: This table reports the coefficients of pooled linear regressions of the sovereign ratings attributed by each rating agency. Standard errors (reported in parentheses) are clustered by countries (they are adjusted for 27 clusters). R^2 indicates the explanatory power of the models; higher values indicate better model fit. *, **, ***― statistically significant at 10, 5, 1%.

5. Summary and conclusions

In this paper, we have empirically analyzed the ability of FSIs proposed by IMF to explain the financial soundness of EU member countries. We examine the impact of capital adequacy, asset quality and earnings core FSIs on the financial strength of EU countries from 2008 to 2011. To the best of our knowledge, literature so far has not empirically examined to what extent FSIs proposed by IMF explain the financial soundness (or lack of risk) of a country. In addition, we explore the possible relationship between financial development level and financial soundness of a country.

Using ratings from the three main international rating agencies as a proxy for financial soundness, we estimate ordered response models at country level, different from

previous studies which analyze the risk at firm or bank level (Demirovic and Thomas, 2007; Poghosyan and Čihák, 2011; Trujillo-Ponce et al., forthcoming).

Seven core FSIs are selected based on previous literature and data availability. Our results provide evidence of the ability of asset quality, capital adequacy and profitability indicators to illustrate the health of the financial sector. Specifically, NPLTGL shows significant positive impact on risk (i.e., negative relationships to financial soundness), whereas NPLNPC and NIEGI appear to be significant but with a negative impact on risk (i.e., a positive effect on financial soundness). The Financial Development Level (FDL) of a country is also found to be significant, so that, the higher the level of financial development, the higher the financial soundness.

Our research reveals two main policy implications. Firstly, some core FSIs related to the banking sector are useful to explain the risk of EU member countries. In this sense, these ratios can contribute to macroprudential analysis although they need to be interpreted with care and we cannot forget that these indicators are only one of multiple tools for macroprudential evaluation.[14] They should be used jointly with other instruments (such as stress test, early warning systems, or supervisory assessment) for a reliable and complete assessment of the financial soundness of countries. Secondly, in addition to many other variables, evaluations made by the three main rating agencies are related to core FSIs, so that an improvement in these indicators could cause an increase in the sovereign ratings with the important implications it has for the markets of countries. For these reasons, government should pay close attention to the evolution of these measures.

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[14]Čihák and Schaeck (2010) expose some difficulties of these indicators such as their aggregate nature which can disguise problems in individual banks, or the fact that some relevant exposures may not be included as in the case of "shadow banking system".

Appendix 1. Financial Soundness Indicators

CORE SET	
Deposit takers	
Capital adequacy	Regulatory capital to risk-weight assets
	Regulatory Tier I capital to risk-weight assets
	Nonperforming loans net of provisions to capital
Assetquality	Nonperforming loans to total gross loans
	Sectoral distribution of loans to total loans
Earnings and profitability	Return on assets
	Return on equity
	Interest margin to gross income
	Noninterest expenses to gross income
Liquidity	Liquid assets to total assets (liquid asset ratio)
	Liquid assets to short-term liabilities
Sensibility to marketrisk	Net open position in foreign exchange to capital
ENCOURAGED SET	
Deposittakers	Capital to assets
	Large exposures capital
	Geographical distribution of loans to total loans
	Gross asset position in financial derivatives to capital
	Gross liability position in financial derivatives to capital
	Trading income to total income
	Personnel expenses to noninterest expenses
	Spread between reference lending and deposit rates
	Spread between highest and lowest interbank rate
	Customer deposits to total (noninterbank) loans
	Foreign-currency-denominated loans to total loans
	Foreign-currency-denominated liabilities to total liabilities
	Net open position in equities to capital
Otherfinancialcorporations	Assets to total financial system assets
	Assets to Gross Domestic Product (GDP)
Nonfinancialcorporations sector	Total debt to equity
	Return on equity
	Earnings to interest and principal expenses
	Net foreign exchange exposure to equity
	Number of applications for protection from creditors
Households	Household debt to GDP
	Household debt service and principal payments to income
Marketliquidity	Average bid-ask spread in the securities market[1]
	Average daily turnover ratio in the securities market[1]
Real estate markets	Real estate prices
	Residential real estate loans to total loans
	Commercial real estate loans to total loans

[1] Or in other markets that are most relevant to bank liquidity, such as foreign exchange markets.

Source: IMF (2006)

Appendix 2. Relevant studies on sovereign ratings

AUTHOR	SAMPLE	AGENCY	METHODOLOGY	DEPENDENT VARIABLE	INDEPENDENT VARIABLES
Cantor and Packer (1996)	- Cross section data (49 countries in September 1995)	Moody´s S&P	- Regression analysis. Linear transformation of the rating scale.	- A regression for each agency and another regression for the average rating. - Scale with 16 categories of ratings (AAA is 16)	Per capita income, GDP growth, inflation, fiscal balance, external balance, external debt, indicator for economic development, indicator for default history and other additional variables.
Afonso *et al.* (2003)	- Cross-section data (81 countries in June 2001)	Moody´s S&P	- OLS estimation. Linear, logistic and exponential transformation of the rating scale.	- A regression variable for each agency. - Scale with 16 categories of ratings (AAA is 16)	Per capita income, GDP growth, inflation, current account surplus, government budget surplus, debt-to-exports ratio, economic development, default history
Altenkirch (2005)	- Panel data (26 countries from 1990 to 2000)	Moody´s	- General to specific model selection strategy (GETS) -Dynamic panel data model estimation procedure	- Moody´s rating transformed from a linear to a logistic scale	Total debt/GDP, Foreign reserves/GDP, Export growth rate, GDP growth rate, GDP per capita growth, inflation rate, fiscal balance/GDP, exchange rate, credit extended to private sector/GDP, Growth in imports, gross domestic savings, Gross fixed capital formation/GDP, total debt/exports, current account/GDP, ethnic warfare, state failure, regime change, democracy, autocracy, political party, political rights, civil liberties, revolutionary wars.
Butler and Fauver (2007)	- Cross-sectional data (86 countries in March 2004)	*Institutional Investor* rating	- OLS estimation (and ordered probit regression)	- *Institutional Investor* rating - Moody´s and S&P rating with 21 categories (AAA is 21). A regression for each agency.	Per capita income, debt to GDP ratio, inflation, underdevelopment index, legal environment index, legal origin dummies
Afonso *et al.* (2011)	- Panel data (130 countries from 1970 to 2005)	Moody´s S&P Fitch	- Linear regression models on a linear transformation of ratings (pooled, random effects, fixed effects) - Ordered response models (ordered probit and random effects ordered probit methods)	- A regression for each rating agency. - Scale with 17 categories of ratings (AAA is category 17)	- GDP per capita, unemployment rate, inflation rate, real GDP growth, government debt, fiscal balance, government effectiveness, external debt, foreign reserves, current account balance, default history, EU and regional dummies
Ratha *et al.* (2011)	- Cross sectional data (Rated developing countries at end-2006)	Moody´s S&P Fitch	- Estimation of a regression model of existing ratings (OLS regression) - Prediction of sovereign ratings for unrated developing countries	- A regression for each agency. - Ratings are converted into a numerical scale with 21 categories (AAA is 1)	Gross National Income per capita, GDP growth rate, debt/exports, reserves/(imports +short-term debt), growth volatility, inflation, rule of law.

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